Performance-enhancing strategies for firms in the microalgae industry

A quantitative study

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Master thesis

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UNIVERSITETET I OSLO

05.06.2014

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2014

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Trykk: Reprosentralen, Universitetet i Oslo

Abstract

BACKGROUND: Microalgae firms face challenges of being in an emergent industry, such as adoption inertia, slow acceptance among potential customers, and opposition among incumbents in existing, shared markets.

OBJECTIVE: The aim of this study is to identify strategies that can enhance firm performance in the microalgae industry in Europe, North-America, Israel, Australia, and New Zealand.

METHOD: This study tested quantitatively whether applying dynamic capabilities, forming strategic alliances, and building brand can meet these challenges and thus enhance firm performance.

RESULTS: 85 firms were received a survey, out of which 43,5% responded. 3 types of regression analyses were performed for the measures of the three hypothesized strategies. These analyses showed support for dynamic capabilities and brand building as performance enhancing strategies, and partial support for strategic alliances.

CONCLUSION: Applying dynamic capabilities and building brand enhances firm performance in the microalgae industry. This is also assumed to be true for strategic alliances, but in this study it was only found partial support for enhancement of firm performance through forming strategic alliances.

Acknowledgements

I would like to thank:

my supervisor, Tommy Høyvarde Clausen, for giving me the right amount of constructive criticism and guidance while still being kind and patient

the Centre for Entrepreneurship for the extensive and useful curriculum

my mother and father for always loving me and supporting me morally, financially, and academically

my son for putting up with me

my sister for always keeping the door open for me

my boyfriend for the love and support

the firms that took a chance on an unknown Norwegian student, and spent their valuable time filling out my survey

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1 Introduction

“It has been suggested that the three major challenges facing humankind in the 21st century relate to food, energy and the environment, including climate change and environmental degradation due to pollution and habitat loss” Dilwyn Griffiths writes in the book *Microalgae and Man* (Griffiths, 2013:131). He continues by explaining how microalgae, if harnessed properly, can be a solution to all these challenges. Microalgae, are unicellular, microscopic organisms, and can produce everything from a wide variety of fuels, chemicals, and skin care ingredients to food, feed, and nutraceutica, in addition to decontaminate wastewater, CO_2 and other greenhouse gases (GHGs)(Singh and Gu, 2010).

1.1 History of deployment

The first known use of microalgae was nutrition for human consumption around two millennia ago (Spolaore et al., 2006). Though it was not assessed for industrial production until WWII in Germany, and this assessment was continued in the US after the war (Becker, 1994:1). Until a couple of decades ago, the interest in microalgae, at least in the West, was mainly academic, and for oxygen and food production on long-term space travels (Spolaore et al., 2006). But as our planet becomes more polluted and resources grow scarcer, a commercial industry is building up around this environmentally friendly, resource-producing biotechnology.

1.2 Challenges for the microalgae industry

There are several identifiable reasons why this production method is not already extensively adopted, and the background for this will be explained in chapter 2. In addition to technical and financial reasons, which will not be discussed in detail in this study, there is also a general unawareness of microalgae as a source of consumer products, and the industry is still identifying target markets and the best ways to meet their needs. Microalgal products and services are in most cases more sustainable, scalable, and environmentally friendly than those they substitute, but market positions still appear uncertain, mainly for reasons “related to customer acceptance, historical aversion to new technologies, and hearty resistance from stakeholders in existing infrastructure” (Nair and Paulose, 2014).

From the extant literature on firm specific strategies in the microalgae industry, and from following successful microalgae firms such as Solazyme and Kuehnle AgroSystems, it appears that firms which have flexible business models and thus employ dynamic capabilities (DC) for their organization, form strategic alliances (SA), and focus on building a brand (BB) around their firm, products, and services, experience success. Since I examined these strategies on a firm level, I chose to look at them from the perspective of a firm-related theoretical framework: the resource-based view (RBV) of the firm. DC describes a firm's organizational abilities to sense and act on new opportunities and threats in fast-changing market conditions (Eisenhardt and Martin, 2000). From an RBV perspective an SA can both constitute a resource (Eisenhardt and Schoonhoven, 1996), and fill resource gaps that a firm may experience (Teng, 2007). When built and protected properly, brand becomes a valuable asset to a firm in gaining a competitive advantage over other firms that serve the same markets (Urde, 1999). The theoretical frameworks will be explained and discussed in detail in chapter 3.

When microalgae firms enter into strategic business relationships with other companies, such as Solazyme with e.g. Chevron, this relationship can have a two-pronged effect where on one side, Solazyme, a relatively young company with untried ingredients, can appear safer and more creditable both to other potential partners, and to the end users, while Chevron can increase sales and respect among the environmentally conscious, (Sarkar, 2012) as microalgae is a sustainable way of producing fuel. SA can also fill resource gaps that will occur when the firm practices flexible strategies and change business models (Teng, 2007). A firm that focuses on BB as a long-term, intangible resource will create greater awareness among potential customers, a higher degree of loyalty among their customers, and control the firm's image and people's impression of it (Hooley et al., 2005). It will also appear more desirable for alliances (Kalafatis et al., 2012). But first and foremost, firms in this industry must focus on being flexible in how they create value for themselves and their customers, and adapt to changing conditions through building DC (Nair and Paulose, 2014).

I therefore propose the following research question:

What are the relationships between DC, SA, and BB and firm performance in the microalgae industry?

1.3 Rationale for choosing this topic

As mentioned, commercial production of microalgae may solve both problems related to resource-depletion and pollution, and the industry building up around this technology is the instrument that will implement it. I would like to see consumer products sustainably produced from microalgae, and am therefore interested in investigating the challenges this industry faces. To execute this investigation, I find it most useful to break the industry up into firms, which are what industries are composed of (Peng, 2009:34). Specifically, I will focus on the challenges which relate to awareness of the benefits of microalgal products and services, finding the best ways to meet the needs of potential customers, and thus finding its foothold as an industry.

Very little is written so far about firm level strategy in the microalgae industry. Systematic searches in Web of Science, Biosis, and Scopus only yielded two results that fall under this category. However, this lack of secondary data was partially what inspired me to choose this specific topic in the first place. My study will add a significant contribution to this body of literature, and it will also complement the other studies, as this will be the first quantitative investigation of firm strategies in the microalgae industry. The endless possibilities of this techno-agricultural industry would be interesting to anyone with a concern for the environment and the future of mankind, and it has been argued that writing about an emerging technology before it has bloomed can be “an excellent stimulant” and play “a mobilizing role for business and political structures” (Šmihula, 2009).

Therefore to investigate how the challenges of the microalgae industry can be overcome, I studied how firm performance is influenced by strategically building DC, SA, and BB. The specific strategies were chosen because they were brought up in what little literature exists on the topic, and from observing the strategies and tactics of renowned firms in this industry (via news and their web pages). See chapter 2 for more background on the microalgae industry.

The resource-based approach to these strategies was tested quantitatively in this emerging industry. Primary data for the study was gathered through a survey of firms and their strategies, tactical activities, and performance. To the best of my knowledge this is the first study that quantitatively examines firm performance in the microalgae industry, and through the RBV theoretical framework.

1.4 Outline for the thesis

Chapter 2 provides more background information and context for the microalgae industry. In chapter 3 the literature found on the same topic as this master thesis is presented, and literature examining the theoretical frameworks that the survey-questions are based on, and that the findings are discussed in light of. The method of the quantitative study is described in chapter 4, and the results with a brief analysis is presented in chapter 5. Results are discussed in chapter 6 along with a presentation of conclusions that can be drawn from the study.

1.5 Definition of terms with abbreviations

B2B or 'the business market': "consists of all the organizations that acquire goods and services used in the production of other products or services that are sold, rented, or supplied to others." (Kotler and Keller, 2012:205)

Brand (BB is shorthand for brand-bulding): "a means to distinguish the goods of one producer from those of another" (Kotler and Keller, 2012:264)

Dynamic capabilities (DC): "The firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die." (Eisenhardt and Martin, 2000)

Industry: "A group of firms producing products (goods and/or services) that are similar to each other." (Peng, 2009:34)

Markets: "Various groups of customers" (Kotler and Keller, 2012:G5)

Microalgae industry: I define the microalgae industry as all firms producing microalgae biomass or ingredients, products containing microalgae ingredients, services which include the utilization of microalgae, or enabling technology for any of the above.

Resource-based view (RBV): "A leading perspective of strategy which suggests that differences in firm performance are most fundamentally driven by differences in firm resources and capabilities." (Peng, 2009:64)

Strategic alliances (SA): “voluntary agreements between firms involving exchange, sharing, or co-development of products, technologies, or services.” (Peng, 2009:219)

Strategy: “A firm’s theory about how to compete successfully” (Peng, 2009:10)

VRIO framework: “A resource-based framework that focuses on the value (V), rarity (R), imitability (I), and organizational (O) aspects of resources and capabilities” (Peng, 2009:71)

2 Background for the microalgae industry

2.1 On microalgae

Microalgae are often, though not always, photosynthetic, unicellular, microscopic organisms. (Griffiths 2013:xi) They are the very bottom of the food chain and live mainly in water, though they can also inhabit the surfaces of e.g. rocks and tree trunks (Throndsen, 2009). There are about 35,000 different described strains of microalgae, and between them they possess a tremendous biodiversity (Borowitzka and Moheimani, 2013:77). Different strains contain (or can be used in the production of) a wide variety of lipids, proteins, amino acids, carbohydrates such as starch, glucose and sugars, vitamins, pigments, enzymes, polymers, alcohols, hydrogen gas, pharmaceuticals and other fine chemicals (Spolaore et al., 2006) (Becker, 1994:1-2). And due to their relatively simple genetic composition they are easily bio-engineered, opening up for seemingly endless possibilities (Borowitzka and Moheimani, 2013:8,17).

2.2 Scope and characteristics of the microalgae industry

The emerging, and relatively turbulent industry forming around this biotechnology produces raw materials, ingredients, finished consumer products, and services such as waste-water treatment and CO2 capture, in addition to enabling technology for all of the above. When searching for firms to survey, I found 93 firms that fall under this category in the western part of the world: Europe, North-America, Israel, Australia and New Zealand. A microalgae industry also exits in Africa (Bolton et al., 2008), South-East Asia, and is building up in South-America (Lee, 1997). The product-related branch of this industry produces mostly substitutes for already existing raw materials, ingredients, and consumer products in mature markets (Enzing, 2014).

One example is microalgal biofuel substituting petroleum-based fuel. Fuel produced from microalgae is not just more scalable in the long run (as the source will never run out), it is also far more environmentally friendly. The biofuel can even be produced in a system connected to a CO_2/GHG-producing production unit, such as the system installed at the distillery that produces the whisky Famous Grouse. The exhaust gasses from the whisky production provides nutrition for microalgae, which is used to produce biofuel. This production process captures 8 kg of CO_2 for every 3 kg of CO_2 that is released from the fuel combustion (ScotlandWhisky).

Another example is omega-3 made from microalgae substituting omega-3 that is extracted from fish oil. The world-wide demand for this is proliferating due to its outstanding health effects. The traditional source for this dietary supplement is fish oil, but the rising demand is already pressing the finite supply, which will lead to further increase in prices and lack of availability. It is also quite unnecessary to go via fish to obtain Omega-3, as the fish acquires this ingredient from its diet. A fish that does not eat Omega-3-containing microalgae will not contain Omega-3 (Rubio-Rodríguez et al., 2010).

2.3 Adoption inhibitors

There are several reasons why this is not already a widely adopted technology for producing biofuel and other consumer goods. One relates to enabling technology and economics: open ponds are still the cheapest alternative, but large, flat, sunny areas are required, and high harvesting costs and the threat of contamination of the culture is not ideal (Wang et al., 2012). Photobioreactors (PBRs) are enclosed glass tubes that have installed light-sources for the photosynthesis, and the possibility of controlling all parameters relevant for microalgal crop growth such as temperature, pH-value, light frequency and intensity etc. This makes PBRs ideal for cultivation, but they are expensive, both to acquire and to operate. It is predicted that the adoption of commercial microalgae production will escalate when the price of PBRs decrease and they are fixed with more energy-efficient light sources (Wang et al., 2012).

Other reasons for the slow adoption of this biotechnology are general unawareness of the existence and benefits of microalgae as a source of consumer product ingredients, and the challenge of finding the best practical applications to meet market needs. As an innovation student, I found these latter challenges the most relevant and interesting to uncover solutions to.

2.3.1 Strategies to overcome the adoption inhibitors

Observing renowned and comparatively successful microalgae firms will reveal that these seek different outputs and markets for their competence and IPR, that they form strategic alliances, and that they focus on branding-activities such as highly functional and visually pleasing websites, creating brand names and logos for their products, and publishing information about firm activities and milestones. The best example may be Solazyme, a San Francisco microalgae firm that serves at least 5 different markets, is involved in at least 10 SAs, and has (for this industry) a state of the art website where they publish relevant and interesting information about the firm, and link to media coverage of their activities. Solazyme also focuses on giving their individual products memorable names, such as Soladiesel®, Solajet™, and Algenist™, and design appropriate logos, packaging, and other visual elements (Solazyme).

2.4 Innovation waves

In a bigger context, the microalgae industry has been appointed part of the predicted sixth wave of innovation (Nair and Paulose, 2014). The Russian early 20th century economist Nikolai Kondratiev brought attention to cycles of growth and decline in capitalist economies (Moody and Nogrady, 2010:19-20). The Austrian-American economist Schumpeter named this phenomenon Kondratiev waves in 1939 (Louçã, 1999) and incorporated this theory into his innovation cycle theories (Moody and Nogrady, 2010:20).

Kondratiev waves, or waves of innovation, describe how bursts of new technology has influenced not just the standard of living, but also the economy since the inception of the modern technological society in the 18th century (Moody and Nogrady, 2010:21-23). This theory describes the cyclical rise and fall of economic upturns and inevitable downturns fuelled by bursts of technological innovation, which has defined most aspects of our civilization since the 1700s (Šmihula, 2009). The nadir of each wave brings an economic depression, as the one the global economy has felt since 2008. But out of these depressions the necessity emerges to create new opportunities with the latest developments in technology that will fill new needs that has arisen since (and in some cases even as a function of) the previous innovation wave (Moody and Nogrady, 2010:8,20-21). The recent financial crisis is a result of the end of the fifth innovation wave, which was fuelled by digital networks,

information technology, telecommunication equipment, and pharmaceutical biotechnology. The way to overcome this economic downturn is to catch the sixth wave; the wave of biotechnology for industrial processes, cleantech, industrial ecology, renewable energy, and green nanotechnology (Nair and Paulose, 2014) (Šmihula, 2009).

2.4.1 The sixth wave of innovation

The sixth wave of innovation will bring sustainability, biomimicry, green chemistry, renewable energy, and industrial ecology, and Nair and Paulose (2014) place microalgae in this context. Moody and Nogrady claim that "In this next wave of innovation, resource scarcity and massive inefficiencies will be the big market opportunities [...] and nature will be our source of inspiration and competitive advantage" (2010:9). They predict that this wave will be driven by digital mapping and online collaboration in addition to bioeconomy and clean-tech. Large scale production of microalgae for use as ingredients in consumer products such as biofuel, nutrition, and cosmetics, and for anti-pollution purposes such as carbon capture and waste water treatment, are a match with the predictions for the sixth wave of innovation, which will consist of innovations spanning sustainability, biomimicry, green chemistry, industrial ecology, renewable energy and integrated systems that comprise one or more of these topics (Nair and Paulose, 2014).

But at the beginning of each new wave, there is a phase of trial and error until the technology has been translated into appropriate applications and their respective markets are ready for them (Moody and Nogrady, 2010:20). Though this next Kondratiev wave is about to rise (Šmihula, 2009) (Nair and Paulose, 2014) (Moody and Nogrady, 2010:8, 20-21), it is seemingly in the trial and error phase presently, hence microalgae firms suffer the challenges that is a consequence of being an extremely early adopter of innovative technology.

2.4.2 Previous waves

The first wave was what is commonly described as the 'industrial revolution' with its efficient production methods for textiles and garments, and improved metallurgy and hydropower (Stokey, 2001). The second wave was led by the invention of the railway and steam engines,

the third electricity, the fourth the automobile, and the fifth information and communication technology. (See Table 1)

Each wave has its idiosyncrasies, but there are three broad phases that can be distinguished by how they affect society economically. The first phase is the ‘innovation phase’ where practical applications of the technology are conceived and experimented with. In this phase the innovation does not directly affect society yet, only scientists, inventors and people who are particularly interested in new technology. E.g. the steam engine, a major driver of the 1st wave of innovation, was invented in 1705, but steam engines were not really used until about 70 years later (Šmihula, 2009). In this phase small, technology driven firms fight for market attention and a dominant design. The firms that start building up around the nascent inventions are typically small and there is much uncertainty concerning the best approach for exploitation of the technology behind these inventions (Šmihula, 2009). This is the phase of the sixth wave of innovation that the microalgae industry is in now.

The second phase, which the microalgae industry will seemingly move into in a few years, is the ‘application phase’. Then the focus is on finding the most functional ‘dominant design’, exploit it financially and evolve further on the ‘dominant designs’. This is the ‘boom phase’ that also brings with it financial prosperity. It commonly happens that the application phase gives way to ‘semi-monopolistic’ firms, e.g. big car and airplane manufacturers, Microsoft, IBM and the railroad barons. At some point in this phase the wave will reach its zenith, after which things will inevitably slow down, and the wave will enter the third ‘deceleration’ phase that ends in a financial depression (Šmihula, 2009). However, the innovations prevail, they have become part of everyday life, and society will have been changed for ever. The reason for the economic downturn is the slowing growth and the decreasing returns on investment, and an economic downturn inevitably follows each wave (Moody and Nogrady, 2010:20-21).

Table 1 The innovation waves, their up- and downswings and technologies (Moody and Nogrady, 2010) (p.23)

	Wave 1: Cotton, Iron, Water Power	**Wave 2: Railways, Steam Power, Mechanization**	**Wave 3: Steel, Heavy Engineering, Electrification**	**Wave 4: Oil, Automobiles, Mass-Production**	**Wave 5: Information and Communication**
Upswing	1780s-1815	1848-1873	1895-1918	1941-1973	1980-2001
Downswing	1815-1848	1873-1895	1918-1940	1973-?	2001-?
Technologies	Cotton-spinning, iron products, water-wheels	Railways and railway equipment, steam engines, machine tools, alkali industry	Electrical equipment, heavy engineering, chemicals, steel products	Cars, trucks, tractors, tanks, diesel engines, aircraft, oil refineries	Computers, software, telecommunication equipment, biotechnology

2.4.3 Future waves and needs

Bradfield Moody and Nogrady (2010:25) indicate that the waves are becoming shorter, something that Kondratiev and Schumpeter did not foresee. Šmihula (2010) also points this out and designate it to the increased speed of innovation and the nature of the new technology. He predicts that in a few waves they will start to blend into each other in perpetual innovation and technological progress. Hopefully this will also mean the end of global economic downturns.

Ultimately the need for more sustainable production methods and resources will be apparent, regardless of predicted innovation waves. Continued polluting will eventually make our planet uninhabitable, and natural resources that are either mined or harvested become depleted as the population increases exponentially. Thus finding sustainable and scalable methods for producing resources is crucial for our continued existence (Moody and Nogrady, 2010:77-100). For this, microalgae is an ideal candidate, as it can be grown all year around and in areas where nothing else will grow (Nair and Paulose, 2014).

2.5 Bioeconomy and industrial ecology

Industrial ecology refers to conglomerate industry systems, where the waste or exhaust from one becomes part of the production process for another, much like by-products in nature (Dara O'Rourke, 1996). Microalgae are increasingly used as components in industrial ecology projects, as they possess the ability to utilize a variety of solid, liquid, and gas-phase substances that are traditionally considered waste and pollution in their production of useful biomass (Borowitzka and Moheimani, 2013:153-161) (Pauli, 1997).

The emergent bioeconomy will fuse various output industries into new, sustainable industries. Golembiewski et al. (2013) suggest that a definition of bioeconomy can include “a sustainable way of production and a cascading (re)use of bio-based products from natural inputs relying on biological processes” but add that this is not enough, “a broad definition should encompass all affected sectors, environmental functions as well as innovation and dynamics of activities, paradigm shifts in production and thus the possibility to enable long-term growth and to capture future needs.” As for the scope, the German government has stated that “bioeconomy involves every sector that develop, produces, uses or modifies biological resources” (Golembiewski et al., 2013).

Golembiewski et al. (2013) examined the converging of the energy industry and the agriculture industry in Germany to gain insight into the process of industry convergence in the light of bioeconomy, and how far this process had developed. In regards to firm performance in converging industries, they observed that “a firm’s flexible response and dynamic capabilities represent to be the key for its future success.” Firms in both the agricultural and energy industries were eligible for bioenergy grants, and there were evidence of industry convergence through e.g. an “increasing number of cross-industrial research collaborations.” What the study found, however, was that for bioenergy there was a greater convergence between biotech and energy firms than with firms in the agriculture industry. Strategic alliances observed between biotech and energy firms include microalgae firms such as Sapphire Energy and Solazyme (Golembiewski et al., 2013).

The serial entrepreneur, writer, visionary, academic, environmentalist and industrial ecologist Gunter Pauli reminds us that humans are the only living organisms which produce matter that nothing and nobody wants, and thus will not be broken down by any natural cycle. His passionate article *Zero emissions: the ultimate goal of cleaner production* (1997) is a call for

action to create our own industrial ecosystem that takes care of our own waste, which nature cannot break down. He explains with practical examples, among them two involving microalgae, how industries all over the world produce prodigious amounts of waste from matter that could not only be used as ingredients in other production processes instead of just becoming waste, but also be monetized to create value and employment. Many initiatives for a more environmentally sustainable future cut down on wastage by making processes more efficient. But Pauli believes that zero waste is the goal, and that it can be reached by creating innovative ecosystems around already existing production industry. And this is where microalgae comes in, as it can clean wastewater that would otherwise upset the ecosystem where it was released, clean CO_2 and other greenhouse gases that would otherwise upset the balance of the gases in the atmosphere or have to be sequestered, feed off biological waste that is normally considered unusable by-product, **and** at the same time produce biomass from which an extensive range of valuable ingredients can be extracted (Pauli, 1997).

And this idea is, and will increasingly become, a basis for microalgal business models and strategies. However, this vision of industrial ecology entails a high degree of cooperation between different types of firms and firms must open up for an unusual extent of flexibility when it comes to where and how to capture opportunities (Nair and Paulose, 2014).

Hawaii-based Kuehnle AgroSystems (KAS) specializes in producing products and services from microalgae and other microbes within the cosmetics, specialty chemicals, wastewater treatment, CO2 capture, and aquaculture and animal nutrition markets (Kuehnle AgroSystems). Foreshadowing the sixth wave of innovation, KAS has a keen focus on industrial ecology, and has realized that “[i]f a goal of industrial biotechnology is to find sustainable, non-food sources for commodity raw materials, such as for biofuels and animal feed, then microalgae that is produced in aerobic sugar-fed fermentation systems has much to offer. To enable this, formation of strategic partnerships among sugar feedstock and manufacturing partners is essential” (Kuehnle and Ritchie, 2013). KAS has explored this sustainable opportunity by forming a strategic R&D/product development relationship with Canadian pulp, paper, and personal care producer Domtar Corporation. They will “monetize underutilized waste products by upgrading wood-based sugars into algae-based fuels, feed, and higher value bioproducts as part of an integrated biorefinery” (Kuehnle and Ritchie, 2013)

The prospect of becoming a part of the sixth wave of innovation, through the emerging bioeconomy, or even in industrial ecology systems, will afford firms in the microalgae industry an increasing amount of opportunities in the coming years. Though they will still experience the challenges of being in an emerging industry, in the foreshadowing of a new innovation wave. It is predicted that the firms which will succeed in these changing environments are firms that build and employ DC (Nair and Paulose, 2014) (Golembiewski et al., 2013), form SAs (Kuehnle and Ritchie, 2013) (Nair and Paulose, 2014), and focus on BB (Nair and Paulose, 2014). Since I will study firms, the building blocks of the industry, it makes sense to use a firm-specific theoretical framework, and hence DC, SA, and BB will be examined and discussed in light of the resource-based view (RBV) of the firm.

3 Review of literature and theoretical frameworks

3.1 The resource-based view of the firm

The RBV of the firm focuses on how tangible and intangible resources can create differences between firms in the same industry (Peng, 2009:64). This framework focuses on the individual firm, and how it can gain a sustainable competitive advantage (SCA) through "the resources and capabilities a firm controls that are valuable, rare, imperfectly imitable, and not substitutable" (Barney, 2001a) "plus have the organization (O) in place that can absorb and apply them" (Kraaijenbrink et al., 2009). Valuable, rare, inimitable, and organization (VRIO) form the cornerstones of the RBV. (Peng, 2009:71) (VRIO is sometimes also referred to as VRIN, in which case the O is replaced by Non-substitutable.) Firm-specific resources and capabilities are central in the RBV framework, and Peng describes them both as "the tangible and intangible assets a firm uses to choose and implement its strategies" (Peng, 2009:64-65).

First and foremost the RBV framework aims to explain why some firms perform better than others, it is not directly aimed at offering advice for managers (Kraaijenbrink et al., 2009). The RBV framework does not offer specific instructions on what resources are the most valuable, rare, and inimitable, and specifically how to organize them, rather makes the manager or scholar aware that in different markets various combinations of resources organized appropriately for that situation can explain one firm's an advantage over others. In order to give more specific resource-based advice, empirical studies must be done for individual markets or industries (Barney, 2001b). This is a very versatile framework which can be applied to or combined with other ways of examining firms and competitive advantage, such as 'human resource management', 'economics and finance', 'entrepreneurship', 'marketing', and 'international business' (Barney, 2001a). Studying the firm from a resource-based perspective has roots all the way back to Penrose in the late 50s (Wang and Ahmed, 2007). Though the RBV framework became more developed in the 80s and 90s as a reaction to the argued shortcomings of theories focusing on industry analysis for competitive advantage (Kraaijenbrink et al., 2009).

Kraaijenbrink et al. (2010) claim that the continued criticism of the RBV framework has strengthened and refined it throughout the decades. The criticisms of this framework have particularly been focused on its scope, focus, and practical applicability on one side, and definitions of terms such as ‘valuable’ and ‘resource’ on the other. Some of these criticisms are made by academics who have misunderstood the nature of this framework, and who expect it to entail parameters that can be measured directly and compared in order to advise managers in decision-making processes (Kraaijenbrink et al., 2009). For this study, I find the discussion of whether SCA is achievable or not particularly interesting. It is increasingly argued that an SCA is unattainable in practice, and that firms that appear to have SCAs instead continually pursue endless strings of fleeting, impermanent competitive advantages. The critique of SCA as an unattainable goal is continued by critics arguing that the VRIO in any case will not lead to SCA. It is argued that though some successful firms may have resources and capabilities that fulfill the VRIO criteria, this does not explain their success, at least not in its entirety. Some critics are also sceptical of the concepts and terminology: “it is not the value of an individual resource that matters, but rather the synergistic combination or bundles of resources created by the firm” and “the RBV is a tautology that fails to fulfill the criteria for a true theory” (Kraaijenbrink et al., 2009) This is where the criticism is constructive, because it calls on RBV scholars to define appropriate terms for the framework’s concepts. “The imprecise and tautological definitions of value offered in the seminal work have triggered several debates around whether value in the RBV is determined endogenously (by the firm), exogenously (by the market), or otherwise” (Kraaijenbrink et al., 2009)

3.2 Dynamic capabilities

Traditionally, the goal for firms as described in the RBV framework was to use tangible and intangible resources to create an SCA (Ambrosini and Bowman, 2009). However, it is argued that in emerging, turbulent industries such as the microalgae industry, nothing is ‘sustainable’, or everlasting, as the market-landscape will change far too often. In these industries, it is better to focus resources on short-lived opportunities, with the ability to exit without great loss. The agility to find and take advantage of short-lived opportunities and prepare for sudden threats is called dynamic capabilities, and is mostly considered part of the RBV framework (Eisenhardt and Martin, 2000).

While the RBV explains how some firms perform better than others in the same markets, it is not concerned with "how future valuable resources could be created or how the current stock of VRIN resources can be refreshed in changing environments: this is the concern of the dynamic capability perspective" (Ambrosini and Bowman, 2009) The conception of, and growing and continual interest in the DC theoretical framework stems from observing that firms that do not pro-actively consider the evolving opportunities and threats in their markets perform worse than firms that do (Barreto, 2009). Scholars have since the 1990s discussed whether the idea of SCA is not too static for the real world, especially in industries that are turbulent and/or emerging (Eisenhardt and Martin, 2000) (Ambrosini and Bowman, 2009). The DC framework, by most scholars considered and offspring of the RBV framework, discuss how to detect and seize opportunities quickly in a post-SCA world, and are described by Eisenhardt and Martin (2000) as "the drivers behind the creation, evolution, and recombination of other resources into new sources of competitive advantage."

The DC literature argues that increasingly there is no such thing as SCA (Wu, 2010) (Day, 2013), but rather ever-emerging waves of opportunities that are best exploited by firms that either predict their emergence, or catch them early on, and that realize when the wave has run its course, withdraw, and move on to find the next. In order to be a firm that can do this in a successful manner, it is imperative to **not** tie up resources in analyzing and planning for sustainable competitive advantages, but rather continually scan and prepare for new, short-lived opportunities by building capabilities within "specific and identifiable processes such as product development, strategic decision making, and alliancing" for dynamic markets (Eisenhardt and Martin, 2000).

Instead of describing the turbulent conditions of emerging industries, Eisenhardt and Martin (2000) focus on the dynamics of the markets they serve and dub them high-velocity markets, referring to the pace at which opportunities and threats arise. They divide markets into slowly evolving, moderately dynamic, and high-velocity, and state that DC take on varying characteristics for the different categories. They explain that "in high-velocity markets where industry structure is blurring, dynamic capabilities take on a different character. They are simple (not complicated), experiential (not analytic), and iterative (not linear) processes. They rely on the creation of situation-specific knowledge that is applied in the context of simple boundary and priority-setting rules." However, for firms operating in the slowly evolving part of the market dynamism spectrum, DC is rather "detailed, analytic routines" (Eisenhardt and Martin, 2000).

Teece and Pisano (1994) introduce that DC relates to two different features of firm context: "first, it refers to the shifting character of the environment; second, it emphasizes the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organizational skills, resources, and functional competences toward changing environment" (Teece and Pisano, 1994) Dynamic here describing the former and capabilities the latter. They specify that the management team must focus on integration, learning, reconfiguration and transformation, and that implementing a strategy of improving one's DC will lead to better performance in comparison to competitors that does not emphasize this.

Teece (2007) disaggregates DC so that the reader can understand it better by examining the building blocks, and starts by identifying three main capacities: "(1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (Teece, 2007).

The sensing of opportunities and threats is a capability that stems from obtaining access to different or better information than one's competitors, and knowing how to shape opportunities from obtained knowledge. Schumpeter wrote that opportunities arise when the market equilibrium is disturbed (Teece, 2007). Globalization and new technology innovation has created markets that are seldom in equilibrium, thus requiring the dynamic capability of perpetual market sensing. Seizing opportunities concerns turning them into useful or desirable products or services. This is the point where investment in the opportunity is needed, and resources must be mobilized. Doing this will often lead to lengthy processing times prior to potential acceptance of investment in the idea. Risk aversion is a killer of innovation. A keen focus on keeping up with fast-paced market conditions is a reason why newer firms can perform better than incumbents, even though they possess less assets. Though a problem that can arise is that when a firm experiences success doing things one way, the management team might believe it to always be the better way (Teece, 2007). A dynamic capability that will make a firm more agile in the marketplace is to have a good system for allocating resources from without or within the firm, to start development of new products and services, and another is to not become stuck in a routine just because it worked once. But even if a firm is organized to sense and shape opportunities and have a good system for financing and developing innovation, the firm still needs dynamic capabilities within continued threat management and resource configuration to keep growing. Teece (2007) mentions redeployment and reconfiguration as keywords for these processes. This might entail

"business model redesign as well as asset-realignment activities, and the revamping of routines" (Teece, 2007).

Teece and Pisano (1994) conclude that DC "is an eclectic paradigm drawing from multiple disciplines, and advancing with the help of industry studies in the USA and elsewhere" and does not relate it directly to the RBV framework, as most of the later articles do. But they claim that the "notion that competitive success arises from the continuous development, exploitation, and protection of firm-specific assets" has a long tradition in the business strategy literature, all the way back to Schumpeter (Teece and Pisano, 1994).

3.2.1 Implementing dynamic capabilities

Zahra et al. (2006) term the 'ordinary' capabilities, e.g. developing new products, 'substantive capabilities', while DC is "the ability to *reform* the way the firm develops new products" (Zahra et al., 2006). They claim that DC is born from a recognition that change must be made to the substantive capabilities, and this recognition often stems from analyzing failure. Thus firms that have experienced failure, but decided to learn from it, and adapt their substantive capabilities, will often become better equipped with DC in future endeavours. Since it can take a long time to develop DC in this way, and making a lot of mistakes can be a costly way to learn, new firms (who have less time and money than larger, mature firms), would do better to not 'learn the hard way', but to become aware that they can build up DC from the start, to gain an advantage over their competition. Zahra et al. (2006) propose that learning types used to build up DC change from improvisation in young firms to experimentation in mature firms, but that the use of imitation (the third learning type in the Miner-school (Miner et al., 1999)) in acquiring DC is not affected by firm age.

Day (2013) offers a concise treatment of how DC should be used. He brings 'adaptive capabilities' into the DC discussion, and states: "the full benefit of these capabilities will be realized by firms that adopt an outside-in approach to the development of their dynamic capabilities" (Day, 2013). The difference of an outside-in approach to capability development as opposed to inside-out, is where and how the management team starts to understand market-opportunities and competitive threats. The outside-in approach breaks down the boundaries between the firm and the market, and places the management team out in the field with the customers, in order to better understand their needs, problems and changes. Instead of focusing on what resources and capabilities the firm has, and what can be done with them, the

firm should focus on what their customers (existing and potential) want and will want in the future, and figure out how to give it to them. “[Sticking to what you are good at] may be a generally good rule, but the problem is the world changes out from under you if you are not constantly adding to your skill set.” ((Day, 2013) quoting Jeff Bezos, founder of amazon.com) The adaptive capabilities “augment and enhance the dynamic capabilities by starting from the outside-in” (Day, 2013). Market learning, market experimentation, and open marketing are three adaptive capabilities that can do just that. The appropriate market learning will build up insight-promoting processes that can detect opportunities and changes with increasing agility and veracity. Market experimentation takes the market learning to the next level, where experiments will govern specifically what information is gathered and thus the learning of the specific target markets, products or services of interest to the firm. Open marketing can include, but is not limited to, open communication with customers about their satisfaction and actively using social media to communicate and receive feedback (Day, 2013).

3.2.2 Idiosyncrasies and commonalities

Eisenhardt and Martin (2000) point out that DC, though on one side inimitable and path-dependent for each individual firm, have many shared characteristics and components across all firms. After all, firms are ultimately composed of mostly same elements and have approximately the same goals. “[J]ust as there are better and worse ways to hit a golf ball or ski a mogul field, there are more and less effective ways to execute particular dynamic capabilities such as alliancing, strategic decision making, and knowledge brokering” (Eisenhardt and Martin, 2000).

These so-called ‘best practices’ can for example be: gathering and relying on real-time information, experimental and iterative operations, and “parallel consideration and often partial implementation of multiple options.” This way firms can learn about market needs and wants as they go. Smaller mistakes will be made continually, but this will be part of the learning curve rather than something to be avoided at all costs (Eisenhardt and Martin, 2000).

Newbert (2005) extends this idea to DC in nascent firms. Since all new firms strive for survival, growth, and success, they need the same things: funding, customers, a good reputation etc. Thus, depending on the degree of dynamism of the markets a firm aims to enter, most of the steps (ingredients) will be the same. What differs is the way or the order in which the steps are executed (the recipe), and DC will relate to the recipe (Newbert, 2005).

3.2.3 DC in start-ups

Start-ups usually have scarce resources, and must thus rely even more on dynamic capabilities to make do with what they have and what they can gather. Newbert (2005) discusses DC in relation to start-up firms, and performed a quantitative study of what sort of competencies enhance performance in nascent firms was performed. The findings from the quantitative study presented in this article show that the following activities were frequently performed by successful young firms: “developing models and/or prototypes, purchasing materials, buying and/or renting facilities and/or equipment, investing their own money in the venture, committing full time to the venture, hiring employees, and engaging in promotional efforts” (Newbert, 2005). However, the number of these activities that showed a statistical significance per firm depended on the degree of dynamism within their target market. Firms operating in highly dynamic markets have fewer gestation activities (2) than firms in moderately dynamic (3) and slowly evolving markets (4). An even more interesting finding from this study was that “writing business plans, organizing start-up teams, projecting financial statements, forming legal entities, and asking others for money were not critical to success for high-technology nascent entrepreneurs” (Newbert, 2005). The study also indicated that prior experience with a successful start-up had no or even negative (in high-velocity markets) effect on the current start-up’s performance.

3.2.4 Criticism of the DC framework

Zahra et al. (2006) criticise DC on several accounts. “The emergent literature on dynamic capabilities and their role in value creation is riddled with inconsistencies, overlapping definitions, and outright contradictions” they claim (Zahra et al., 2006). Inconsistencies stem from a “lack of agreement about whether a dynamic capability refers to substantive capabilities in volatile environments or to the organization’s ability to alter existing substantive capabilities, regardless of the volatility of the environment.” The term ‘substantive capabilities’ refer to “the set of abilities and resources that go into solving a problem or achieving an outcome.” The distinction from DC can be illustrated by this example: “[a] new routine for product development is a new substantive capability but the ability to *change* such capabilities is a dynamic capability” (Zahra et al., 2006).

The authors also point out the difference between referring to DC as valuable in itself, and that it is an instrument for value creation, mirroring some critiques of RBV. “The result is that

dynamic capabilities have been conceptualized and assessed in ways that make it difficult or even impossible to separate their existence from their effects" (Zahra et al., 2006). Yet another point they stress is that some of the literature has confused "the presence of dynamic capabilities with environmental conditions." Although DC is usually considered in relation to high-velocity market conditions, this means neither that they automatically coincide, nor that they are the same.

Wang and Ahmed (2007) point out that not enough empirical work has been done on the topic and that the findings from what has been done has not to a sufficient degree been connected to the theoretical concepts. They also find contradictions within the DC literature and "mixed use and interpretation of terminologies" (Wang and Ahmed, 2007).

3.2.5 Flexibility and DC in the microalgae industry

Nair and Paulose (2014) describe current challenges for green technology firms and emphasize that "to be competitive in these ever-changing environments, firms need to be flexible enough to respond effectively to changes" and that "flexibility grants the organization dynamic capabilities for choosing the most productive method of staying sustainable" (Nair and Paulose, 2014). It is paramount for firms in emerging clean-tech industries to stay flexible, even on a strategy level. Not deciding on and sticking to a business model from the start, but rather finding out what actually works best as the firm finds its place in the value chain and business ecosystem, will open up for the best and largest set of options. Strategic flexibility will also afford the green industry firm better options in the marketplace, responding to opportunities and threats. It is recommended that management not only "regularly review their firms' strategies, [but also] processes, relationships, routines, and values to avoid organizational inertia" (Nair and Paulose, 2014)

Kuehnle and Ritchie (2013) specifically mention "flexibility and responsiveness in meeting customer needs" as success factors for Kuehnle Agrosystems, and in particular for the purpose of initiating strategic relationships, which they underline as crucial for the survival and success of a microalgae firm (Kuehnle and Ritchie, 2013). A German study of emerging bioeconomy-related industries also concluded that DC and "flexible response" were important strategies for firms in these industries (Golembiewski et al., 2013).

Based on the DC theoretical framework and recommendation for dynamic and flexible firm strategies found in the literature on the microalgae industry, I hypothesize:

H1: There is a positive relationship between dynamic capabilities and performance in the microalgae industry.

3.3 Strategic alliances

Application of DC can lead to resource gaps, which can be filled by forming a strategic alliance with a firm that possesses resources that can fill the gap (Teng, 2007). This is one reason why strategic alliances are argued to be performance enhancing for firms that are in a turbulent industry and that focus on DC. Building a brand, which will be discussed in section 3.4 can make a firm more visible and the brand can become a resource which makes the firm more desirable for other firms to alliance themselves with (Das and Teng, 1998) (Nair and Paulose, 2014).

3.3.1 Strategic alliances and resources

Inter-firm cooperation is estimated to be one of the success factors in increasingly competitive high-velocity markets. Both tangible and intangible resources can be shared, combined, and improved in alliances, and when looking at strategic alliances from the RBV, resource sharing and/or combining is the main motive for entering an alliance (Das and Teng, 1998). Many different types of resources can be valuable to an alliance-partner: a local network or local knowledge, technical expertise, equipment, venues, or patents (Das and Teng, 2000).) The way that RBV apprehends SAs is different from that of most other theoretical frameworks. “In contrast to the transaction cost logic, which emphasizes cost minimization, the resource-based rationale emphasizes value maximization of a firm through pooling and utilizing valuable resources. That is, firms are viewed as attempting to find the optimal resource boundary through which the value of their resources is better realized than through other resource combinations” (Das and Teng, 2000). An alliance can also grant a firm quicker access to cutting edge technology and new markets (Das and Teng, 1998).

In addition to providing resources, strategic alliances are commonly viewed as a resource in itself through the RBV lens (Eisenhardt and Schoonhoven, 1996) (Das and Teng, 2000). In light of the RBV framework Eisenhardt and Schoonhoven (1996) write that “resources

provide both the needs and opportunities for alliance formation". This is elaborated on further by describing that firms in unstable, competitive market-environments may need tangible or intangible resources that can strengthen their position, and that firms 'in strong social positions' have the intangible resources such as network and a strong reputation to attract potential alliance partners. "Alliances also improve the strategic position of firms by enhancing legitimation. Cooperating with another organization can give a firm visibility and signal enhanced status to would-be buyers, suppliers, and employees" (Eisenhardt and Schoonhoven, 1996). This can especially give a competitive advantage in emerging markets that are characterized by a lack of predictability and turbulent changes in market shares because "alliances can often improve the market power of a firm, either because the alliance partner is a customer for the product or because the distribution channels and buying power of the partners can be combined" (Eisenhardt and Schoonhoven, 1996). The prodigious set of advantages that strategic alliances hold for firms in emerging markets are expanded by market-legitimation in the eyes of potential buyers and as 'dominant designs' are still unclear in emerging markets, a legitimacy-enhancing alliance may promote one firms 'design' over others (Eisenhardt and Schoonhoven, 1996).

3.3.2 Formation of strategic alliances

Thus not all firms are equally eligible for alliance formation due to, for example, an underdeveloped network. A firm that has a well-connected top management team, whose members have previously been employed in the focal industry and ideally has experience with negotiation, will be more likely to find good alliance options (Eisenhardt and Schoonhoven, 1996). Once an alliance opportunity is identified, the potential business partners must unveil their intent prior to a formal agreement. Firms often take different roles in alliances because of their varying tangible and intangible resources. "For example, one partner may be oriented toward controlling the venture, while the other partner's orientation could be about securing its technology" (Das and Teng, 1998).

3.3.3 Strategic alliances in the microalgae industry

Kuehnle and Ritchie (2013) reveal some of their experiences as top managers of a firm that has had success in the microalgae industry. They view formation of strategic alliances as perhaps the most important tactic for firms in their industry. Though being open to strategic

relationships is not enough to succeed, a small microalgae firm must “develop a compelling basis for large companies to engage with them in strategic alliances”. Alliances will provide the biotech start-ups beneficial options, such as increased revenues from sales and licensing, and possible exit-options from an IPO or acquisition (Kuehnle and Ritchie, 2013).

Kuehnle AgroSystems (KAS) has established a number of strategic business relationships since its formation, and Kuehnle and Ritchie attribute their success in these endeavours to building a reputation for technical expertise and innovative abilities and a willingness to be flexible to the wants and needs of their customers (Kuehnle and Ritchie, 2013). One of their strategic business relationships is with Nikko Chemicals Co. Ltd., a Japanese firm that produces cosmetics ingredients. It is an R&D relationship that has resulted in products that are soon to enter the market. The authors note that “[w]hat makes this strategic relationship possible is that both companies see algae as a growing platform for the development of natural, sustainable, and competitive products for the global cosmetics industry.” They perceive such relationships as a way to “establish trust and build a foundation for long-term partnerships that will assist KAS in its growth” (Kuehnle and Ritchie, 2013).

It is obvious that to be part of an industrial ecosystem, a firm must cooperate with other firms. The available literature also recommends cooperation for clean-tech/microalgae firms that is not part of an industrial ecosystem, as strategic business relationships will help build durable and efficient value chains. “Firms building partnerships and business models structured to accommodate these partnerships can be influential. This approach has advantages for branding, supply chains, and the emergence of new business models” (Nair and Paulose, 2014).

Based on the theories of SA seen in light of the RBV framework and recommendations for firms to form strategic alliances in the literature on the microalgae industry, I hypothesize:

H2: There is a positive relationship between building strategic alliances as a resource and firm performance for firms in the microalgae industry

3.4 Brand-building

3.4.1 Marketing activities within the RBV

The examination of marketing activities from a resource-perspective as the cause of competitive advantage has increased fivefold in the past 10 years, indicating that it is becoming an important branch of the RBV. Marketing can be viewed as a resource- and capability-building activity, developing intangible resources that that will become an asset to the firm and amplify the future performance of the firm. In this framework marketing-based resources include, but are not limited to, "building brands, relationships, innovations, or knowledge" (Kozlenkova et al., 2013). Research on marketing from the RBV perspective has mainly focused on the value part of VRIO, but this is to sell short marketing as a resource. Marketing-based resources are also difficult to imitate, as they are path-dependent and rare as they become firm-specific. The proper organization of such resources and capabilities is a necessity in order for them to become or stay valuable (Kozlenkova et al., 2013).

Hooley et al. (2005) describe market orientation as a resource that becomes profoundly interwoven with firm culture, and that will strengthen the firm's position in the market. In addition to the financial benefits of this, market orientation is a resource that is hard for competitors to imitate, precisely because it is not the sort of resource that is created by performing one specific action at one point in time, but rather is built perpetually and becomes embedded in every aspect of the firm. It is hard to discern how marketing resources are created for competing firms looking to imitate such a resource, because of "complexity (arising from the interplay of multiple resources), tacitness (intangible skills and knowledge resulting from learning and doing), path dependency (the need to pass through critical time dependent stages to create the advantage), economics (the cost of imitation), and legal barriers (such as property rights and patents) [...] Resources such as brand reputation, relationships with customers, and market orientation all display the characteristics noted above" (Hooley et al., 2005).

The "market-based resource perspective suggests that marketing research increasingly focuses on intangible, complementary resources, whose effects on the firm's sustained competitive advantage and performance may be greater than the effects of tangible resources. As much as 70% of a firm's market value may come from its intangible resources, and organizational

performance increasingly seems tied to intangible resources, such as customer relationships or brand equity" (Kozlenkova et al., 2013).

3.4.2 Brand as a resource

Urde (1999) discusses the importance of the intangible values of branding, and how these values can become firm resources as described in the RBV framework. "Brand orientation is an approach in which the processes of the organization revolve around the creation, development, and protection of brand identity in an ongoing interaction with target customers with the aim of achieving lasting competitive advantages in the form of brands" (Urde, 1999)

When a firm builds a brand it will draw on many different capabilities and assets throughout the organization. In a process that will happen over some time, value and meaning will be created from the firm's competencies and resources, to become the controlled experience of the firm as seen from the outside. "Ideally, this brand identity is experienced by customers as valuable and unique and becomes difficult for competitors to imitate. In this way, the brand can become a competitive advantage and an expression of an intention" (Urde, 1999) The primary market-based resource consists of the relationships the firm builds with its customers (Hooley et al., 2005).

3.4.3 Elements of brand building

Two important capabilities for a firm to build if they want a strategic market orientation, are "'market sensing' (the ability to continually sense, interpret, foresee, and react to changes in the market) and 'customer linking' (the ability to develop relationships with customers)" (Urde, 1999). The capability to build strong customer-relationships entails to first identify their needs and wants and then to strengthen relations between the organization and the customers. Reputational assets are also important market-based resources that stems from the repute and integrity of the firm among all of its stakeholders. A very important part of the market-based resources of a firm is its human resources. "The employees of the firm are the conduit through which marketing strategies are implemented. Even the most creative, innovative, and well-crafted strategy will fail if the people charged with its execution are not equipped to do their jobs, both physically and mentally, or motivated to deliver" (Hooley et al., 2005)

Sarkar (2012) brings up the added value of promoting a ‘green’ profile. The trend of sustainable or environmentally friendly (green) products materialized in niche markets already in the late 80s. Since then, targeting an ever increasing segment of conscious consumers through green branding has become its own branch of niche marketing. “As rising environmental concerns are encouraging consumers to have greater awareness of their purchase decisions, firms are implementing measures geared to offering green substitutes for traditional products. Consumers and companies alike are consequently more willing to pay premium prices for green alternatives” (Sarkar, 2012).

Social responsibility and ecological sustainability are new ways for firms to differentiate themselves and create a likeable, respectable brand image. Because consumers have the power to choose what products to buy, and are becoming progressively informed and environmentally conscious, businesses in most sectors have to ‘clean up’ in order not to lose market shares. “‘Environmental sustainability’ is not simply a matter of compliance or risk management. Business is increasingly recognizing the many competitive advantages and business opportunities to be gained from eco-sustainability and green marketing” (Sarkar, 2012).

3.4.4 The nature of a brand

Urde (1999) explains that the difference between a brand and a product (even if the brand represents just this product) is the tangible and imitable versus the intangible and inimitable. A well-functioning brand will not just be experienced by the brain, but also by the heart. A product, on the other hand, can easily be compared to other similar products with tangible measurements such as size, color, weight, durability and other performance measurements. A brand possesses “a personality and identity of its own [which] provides a basis for a unique relationship. A product fulfils a function, while a brand symbolizes values and a meaning in a social context. [...] in the analysis of a brand, the experience is the reality” (Urde, 1999)

3.4.5 Business-to-business (B2B) branding

Branding in the commercial microalgae industry can take many forms due to the many different activities a microalgae firm may perform. But for the most part these firms operate in B2B markets, and must consider that if they focus on strategically building brands as resources that will enhance their performance. It is perhaps more common to consider brand-

building as an important activity in marketing towards consumers, but B2B brand-building has been proven to enhance awareness of products and services for firms that operate within the B2B sector and promote higher margins and loyalty, and mitigate rivalry (Kalafatis et al., 2012). Literature on organizational buying behavior suggests that the perceived identity and credibility of the supplier firm influences buying decisions. The supplier firm's brand equity can, even in situations where product functionality has precedence, reduce apprehended risk of trying new products (Kalafatis et al., 2012). Thus B2B branding is an increasing field of focus.

Firms that operate in B2B markets commonly makes the mistake of either not emphasizing brand-building at all, or thinking that it is only important to brand their products, and do not build a brand around the firm itself. This will lead to undervaluation of the firm (Kapferer, 2012:116-117). The favorable results of B2B branding activities, and intense rivalry between entities on the same value chain level has paved the way for brand alliance strategies. There exists several different brand alliance categories that involves various degrees of commitment, with running two or more brands/products in the same advertisement being in the least committed end of the spectrum and co-produced, co-branded products in the most. "We consider a firm's potential benefits from a brand alliance to be financial (for the co-branded product and others in the company portfolio), functional (accessing co-specialized resources such as distribution or technical expertise), and psychological (increased awareness and trust)" (Kalafatis et al., 2012).

3.4.6 Brand building in the microalgae industry

"An important factor that determines the position of a firm in the industry is its brand management capabilities. Efficient brand management is a prerequisite for developing supply chain networks and forming partnerships. In situations marked by increasing competition, the effort to maintain brand value cannot be separated from taking risks or being innovative" (Nair and Paulose, 2014). 'Green' is becoming a brand in its own right, and microalgae firms do well to capitalize on that. If a firm can build a strong, green brand-image, firms and corporations that want to add some 'green' to their brand will seek them out for strategic alliances and co-branding activities (Sarkar, 2012).

The microalgal biofuel for the aviation industry case examined by Nair and Paulose (2014) shows that association with firms in the clean-tech industry aids airline brand-building.

Because the airline industry is known to be responsible for a substantial portion of the total global GHG emissions, airlines are eager to co-brand and perform e.g. biofuel R&D with clean-tech firms (Nair and Paulose, 2014).

Based on the theories of BB seen in light of the RBV framework and recommendations for firms to build brands in the literature on the microalgae industry, I hypothesize:

H3: There is a positive relationship between building brand as a resource and firm performance for firms in the microalgae industry

3.5 Pattern strategies

This study investigates whether certain strategies will enhance firm performance in the microalgae industry because they will aid the firms in overcoming some of the challenges that this industry faces. 'Pattern strategy' one of Mintzberg's five Ps of strategy is described as "*consistency* in behavior, *whether or not* intended". A pattern strategy differs from a plan type strategy in that instead of deciding on a desired outcome and then planning the tactical steps that will reach this goal down the line, the firm believes that consistently adhering to certain tactics will enhance performance down the line (Mintzberg, 2003:4-6). Emergent strategies and entrepreneurial strategies are other terms for more or less the same form of strategy (Mintzberg, 20035-6).

Pattern strategies have some elements in common with Eisenhardt and Martin's (2000) description of the 'shape' and functionality of DC under 'high-velocity' conditions, such as "simple routines [that] keep managers focused on broadly important issues without locking them into specific behaviors […] Often the routines consist of a few rules that specify boundary conditions on the actions of managers or indicate priorities, important in fast-moving markets where attention is in short supply" (Eisenhardt and Martin, 2000). These described 'simple rules' or guidelines form a semi-structure which leaves enough space for flexibility to account for the unexpected. Eisenhardt and Bingham (2011) studied these simple rules further as rational heuristics, and describe these as "unique rules of thumb that guide key organizational processes [which] are not just cognitive shortcuts. Rather, they are also the basis of value-creating strategies that can be more effective than information-intensive, cognitively demanding approaches." (Bingham and Eisenhardt, 2011)

I propose that by following pattern strategies that develop DC, SA, and BB, firms in this industry will perform better than those who do not. I will test these hypotheses empirically by measuring them as described in chapter 4. Though I will treat DC, SA, and BB as three different strategies, I realize that they are not initially concepts on an equal level, and are not commonly investigated together. In addition to examine all three in light of the RBV framework, I will treat them on an equal level by viewing them for the empirical purposes as pattern strategies, and use their respective tactics as part of the construct. Table 2 shows consequences for firms that either 'not at all' or 'very much' follow each of the proposed strategies.

Table 2 Consequences for firms if they 'not at all' or 'very much' follow the three pattern strategies of adopting DC, forming SA, and focusing on BB for the firm and/or its products or services. The consequences are based on the description of the strategies in this chapter.

Dynamic capabilities	
Not at all	Very much
Danger of implementing and following strategies that are antiquated or redundant for the current and future market and competition landscape Danger of assuming that enough can be known about how markets and competition will be, based on analysis, planning and knowledge from previous situations	Agility to respond quickly to threats and opportunities No expenses on long term planning and analyses Learning from mistakes and keeping options open
Strategic alliances	
Not at all	Very much
No sharing of information for better or worse No opportunities to co-develop p/s with another firm's competence/experience and IPR Miss opportunities to find/reach new potential customers through partner Harder for firm to gain recognition	Access to the information, competence, patented technology etc. from another firm, but must give up something in return Access to new or bigger parts of markets Easier access to markets Can "borrow" credibility from partner

Brand building	
Not at all	Very much
Less memorable + less exposure = less awareness among potential customers Less value communicated Less control over how the firm and its products/services are perceived	More memorable + more exposure = higher awareness among potential customers The value offerings are properly communicated Control over how the firm, products and services are perceived

4 Methodology

4.1 Design

A cross-sectional research design and a quantitative research strategy was chosen for testing the hypotheses and answering the research question because it is the most appropriate research design and strategy for investigating relationships across a definite population such as the firms of an industry (Wilson, 2010:14-15). Primarily the theoretical frameworks (described in chapter 3) and their role in firms in the microalgae industry were tested, and the study is primarily of an explanatory nature. But since the frameworks of DC, SA, and branding have never been tested together as a set of pattern strategies for firms in turbulent industries, and because neither (to my knowledge) have been tested quantitatively for firms in the microalgae industry, this it also has an exploratory side. A few of the questions are aimed at identifying firm-specific aspects of the microalgae industry to obtain an idea of the industry landscape in order to better understand the context.

The focus of the study is on firms in the microalgae industry, and whether a set of strategies discussed in the available literature on this industry, approached from the perspective of the RBV, enhances firm performance. To test the hypotheses a quantitative study of firms performing microalgae activities was conducted in the form of a survey. The questions that measure the independent variables were based on tactics derived from the strategies of the theoretical frameworks.

4.2 Sample and population

The microalgae industry in the western part of the world (North-America, Europe, Israel, Australia, and New Zealand) provides the population of firms for this study. The decision to not include all geographic areas was made because of possible loss of information due to the language barrier, and differences in business culture and markets. Firms performing any kind of commercial activity related to microalgae were included. The methods utilized for finding firms were google search, LinkedIn groups related to microalgae, and lists that were published on the internet. As not too many firms had ‘search engine optimized’ their web pages, and lists were far from complete due to lack of search engine optimization and the fact firms

emerge and vanish frequently in this industry, I also used microalgae related LinkedIn groups that I was a member of to find firms and draw attention to my cause. The sample that the survey was sent to consists of the 85 firms that I obtained an email address for and contacted via QuestBack. Some of the firm web pages contained direct email addresses to members of the management team, some had info@firm.com type addresses, but many only had contact forms. In all cases I wrote them an initial request to send them a survey, and in some cases this resulted in a reply with a direct email address. In other cases it resulted in a decline, but in most cases I received no response. Thus many of the email addresses entered into QuestBack were of the info@firm.com kind, and those firms that did not provide an email address on their web page and did not reply, did not become part of the subset that received a survey invitation. However, some firms did not provide an email address on their web page and did not reply when I contacted them via their provided contact form, thus the whole known population consists of 93 firms, out of which 85 was sent a survey. A total of 37 firms, representing a response rate of 43.5% completed the survey. Though I cannot be certain that I found every single microalgae firm in the western part of the world, to the best of my knowledge the subset that was sent a survey is 91.4% of the whole population.

Although 43.5% is a good response rate, 37 is not a high absolute value of respondents in a quantitative study. However, Wilson (2010:213) state that “a minimum sample size of 30 can be used for statistical reasoning to be valid,” and thus 37 should be considered sufficient, especially considering the total population is quite small.

The commercial microalgae industry is relatively small and young. This caused certain challenges for gathering both primary and secondary data. Since this is an emerging, turbulent industry many firms refused to share the information required to complete the survey. To obtain the 37 replies I made personal contact with employees or managers at some of the firms to establish trust and also brought attention to my efforts through LinkedIn groups.

4.3 Survey

4.3.1 Survey distribution

In order to obtain the best possible primary data, the online survey application QuestBack was used. QuestBack allows you to build and test surveys as well as distribute them via email and

automatically send out reminders to the firms that have not replied. The initial survey invitation was sent out on 14.03.2014, and reminders on 18.03, 20.03, 24.03 and 31.03 of 2014.

4.3.2 Survey development

The survey questions were developed with the intent of obtaining primary data that could test the hypotheses, and to find relevant information on the microalgae industry to understand the context. Some questions were borrowed from previous surveys, and some of the dependent and control variables and most of the independent variables were extracted from articles or other relevant texts. (See Table 3) A few of the questions had to be tailor-made for this study, and were not possible to extract from the literature or another survey. These are the questions relating to the microalgae industry (such as what microalgae activities the firm performs), as I found no published material surveying firms in this industry.

The face validity of the survey was tested by my supervisor, Tommy Høyvarde Clausen, who is a research professor and has long experience with quantitative studies and developing questionnaires.

Table 3 the type of variable for each survey question, what it measures, and where it is taken from

Q#	Type of variable	What it measures	Reference (if any)
Q01	control/ exploratory	The type and range of microalgal activities performed by the firm	
Q03	control	The type and range of geographic levels that the firm operates in	(Morris et al., 2005)
Q04	control	Firm size by number of employees	(Brush and Chaganti, 1999)
Q05	control	Firm age (years)	(Brush and Chaganti, 1999)
Q06	dependent	Firm performance by net profits 2013	(Wiklund and Shepherd, 2003)
Q07	dependent	Firm performance by increase in net profits from 2012 to 2013	
Q08	dependent	Firm performance by a comparison to its two closest competitors in regards to sales growth, adoption of new technology, product/service information and variety and customer satisfaction	(Wiklund and Shepherd, 2003)
Q09	exploratory	Perceived industry turbulence	(Green et al., 2008)

Q#	Type of variable	What it measures	Reference (if any)
Q11	independent	Dynamic capabilities by number of changes made to business model	(Per Davidsson, 2012)
Q12	independent/ exploratory	The factors that instigated the business model changes in Q11 (related to dynamic capabilities)	(Per Davidsson, 2012)
Q13	independent	Dynamic capabilities by tactics extracted from article (Likert type added up to Likert scale)	(Day, 2013)
Q14	independent	Dynamic capabilities by dynamism of firm organization (Likert type added up with the rest of the dynamic capability measures)	(Day, 2013)
Q15	independent	Dynamic capabilities by tactics extracted from article (Likert type added up to Likert scale)	(Eisenhardt and Martin, 2000)
Q16	independent	Firm's involvement in strategic alliances based on number of business relationships over the past three years	
Q17	independent	The type and range of strategic business partners of the firm	(SSB, 2010)
Q18	independent/ exploratory	The firm's involvement in strategic alliances that can also function as co-branding, extracted from article	(Kalafatis et al., 2012)
Q19	independent	Brand-building activities, extracted from articles and a blog	(Baumgarth and Schmidt, 2010) (Hooley et al., 2005) (TopRank)

4.4 Variables and measures

Some of the variables, such as firm age, number of employees, net profits, and number of SAs could be measured directly. However, for the most part, the independent variables could not, so constructs for measuring to what degree a firm focuses on the different strategies were created. A construct represents a connection between theory and reality, so that reality becomes possible to measure (Ringdal, 2007:77-78). The constructs in this study were based on tactics described under the theoretical frameworks for the three strategies that I measure.

For the measurement scales I used Likert type answer alternatives where applicable. These were added up to Likert scale measurements. The rest of the questions were either tick one or

tick all that apply. These were assigned values and added up where appropriate, for details see Table 4.

4.4.1 Dependent variables

The dependent variables in this study measures firm performance. Firm performance is a complex, ambiguous concept, and can thus be hard to measure by survey. Therefore three different ways of measuring this was used: net profits for 2013, increase in net profits from 2012 to 2013, and a comparison of the firm with its two closest competitors for sales growth, adoption of new technology, product/service information, and customer satisfaction. The absolute value of the net profits is likely to be correlated with firm size or age, perhaps especially in a nascent industry. The net profit increase in percent could even out this out when measuring the independent variables. Though in an emerging, technology-based industry firms may not be able to quickly transform their efforts into profits, and it should thus not be the only measure of firm performance. Therefore question 8 was added, in which the respondent compares his or her company to its two closest competitors in regards to sales growth, adoption of new technology, product/service information and variety, and customer satisfaction. These three different firm performance measures were added up to one dependent variable for the regression analysis.

4.4.2 Control variables

When surveying all firms within one industry there are many variables that can be controlled for, as they may influence firm performance. In order for the survey not to become too long choices had to be made, and it seemed most likely that the types and range of microalgal activities performed, country of origin, geographic levels of operation, firm size, firm age, and whether the firm has other sources of income than microalgal activities could influence the dependent variables. All these control variables were measured through the survey, but in the end when the absolute value of respondents is as low as 37, you cannot make regression models with more than two control variables. Thus the Size and the Age variable was chosen as control variables for the analyses. The size of a firm may have an impact on its performance (Orlitzky, 2001) (Brush and Chaganti, 1999), and so may firm age, and these variables ought thus to be controlled for in studies focusing on firm performance (Brush and Chaganti, 1999).

4.4.3 Independent variables

The purpose of the study is to measure firm focus on DC, SA, and BB against firm performance. A construct measuring these strategies based on questions taken either directly from other questionnaires or constructed from descriptions of appropriate tactics extracted from literature was created. Question 11, 13, 14, and 15 is added up to measure DC. As can be seen from Table 4 they do not all have the same types of answer alternatives, and thus have different total scores. This was not adjusted for when they were added up, because some of the questions have more sub-questions than others, and therefore should be weighted more strongly anyway. And although e.g. Q11 can obtain a total score of 20, compared to max scores of 5 for Q13, 2 for Q14, and 8 for Q15, a firm will only obtain the max score if they changed all four proposed business model elements 5 or more times over the last three years. The means laid between 2 and 3 business model element changes for each of the sub-question. Q11 is a measure of the results of applied DC, whereas Q13, Q14, and Q15 measure DC intent or organization. SA and BB are measured by one question each, Q16 and Q19, respectively. Q16 simply add up the number of strategic alliances over the past three years. For Q19 a Likert type measurement was used to identify firm focus on brand building activities, which gave a total range from -16 to 16. The question text from the independent variables and how they were measured and added up for analysis can be found in Table 4.

Table 4 the independent variables and the methods used for measuring them

Q#	Question text	Measuring method
Q11	In the last 3 years, how many changes have there been to the following business model elements? (Single select matrix with answer alternatives: none, 1, 2, 3, 4, 5 or more) The products or services that you sell or intend to sell What customers you sell to or intend to sell to The method for promoting or selling The method for producing or sourcing the products or services that you sell	Each sub-question is assigned value from 0-5 (0=none...5=5 or more), and these are added up giving min score 0 and max score 20 → added up towards DC

Q#	Question text	Measuring method
Q13	In the last 3 years, has the firm performed any of the following activities to keep up with possible opportunities and threats? Scanning for changes in customer needs Looking for new ways to meet customer needs Looking for new ways to help customers increase their profits Scanning for new competitors Looking for new ways to stay ahead of competitors There are not enough new opportunities nor threats to justify such activities	Each sub-question is 0 (unticked) or 1 (ticked). These are added up with the formula (A+B..+E), apart from F → added up towards DC
Q14	In the last 3 years the firm has been organized so that it can act quickly on perceived opportunities or threats (Likert type answer alternatives)	Integer scores from -2 (strongly disagree) to 2 (strongly agree) → added up towards DC
Q15	Please indicate to what extent you agree or disagree that the following statements were true for your firm over the past 3 years: (Likert type answer alternatives single select matrix) When developing new products and services, the firm has made prototypes for early testing before making final decisions When developing new products and services, the firm has proceeded in an iterative fashion (going back and making changes based on testing results or feedback) When developing new products and services, the firm has used parallel considerations and partial implementation as a way of testing different options and providing fallback positions The firm has a set of simple guiding rules that all managers can stick to when making quick decisions in fast-changing market conditions	Each sub-question is assigned integer scores from -2 (strongly disagree) to 2 (strongly agree) → added up towards DC
Q16	How many alliance, partnerships, or other strategic business relationships has the firm been involved in over the last 3 years? (Answer alternatives none, 1, .., 10, >10)	Possibility of scores from 0-11. → added up towards SA
Q19	Please indicate to what extent you agree or disagree that the following statements were true for your firm over the last 3 years: (Single select matrix with Likert scale) The firm recognizes brand as a valuable asset and a strategic resource which is continually developed and protected The firm has registered trademarks for names, logos or other visual elements Business decisions are evaluated with respect to their impact on the brand All employees are made familiar with the values represented by the brand The behavior of sales staff and other employees who are in contact with customers is as consistent as possible with the brand identity The firm has allocated resources to building a high quality website The firm regularly publishes information about firm activities that could be of interest for its customers through e.g. the website, a blog, or social media Customer satisfaction is systematically and frequently assessed	Each sub-question is assigned integer scores from -2 (strongly disagree) to 2 (strongly agree) → added up to BB

4.4.4 Construct validity

Most of the independent variables could not be measured directly, thus a construct for measuring firm focus on DC, SA, and brand-building had to be designed. As described in the theory chapter each of these focus areas were investigated as sub-frameworks within the RBV and viewed as pattern strategies that a firm can follow to enhance its performance in this turbulent, emerging industry. Hence for DC, SA, and brand-building seen as strategies subsequent tactics were derived from the literature that the presence of, or focus on, could be measured in a survey.

As many of the survey questions as possible were either directly borrowed from previous surveys of firms, or extracted from firm-specific tactics described in academic articles. This was done to ensure that the questions would be of as high quality as possible and that they would measure what they were meant to measure.

The internal reliability of the composite variables was tested using Cronbach's alpha, to find out whether they "consistently reflect the construct that it is measuring" (Field, 2009:673). Again, it is incorrect to claim an accurate limit for satisfactory Cronbach's alpha scores because it varies with e.g. the number of items. But as a guideline, scores above 0,7 is commonly viewed as an indication of a reliable scale. (Field, 2009:675). This was done for the DC, BB, and Performance variables. It was not performed for SA as it is not a composite variable. The result of the Cronbach's alpha test was 0,771 for DC, 0,892 for BB, and 0,779 for Performance.

4.5 Methodological considerations and limitations

With the above mentioned criteria, 93 companies were contacted. Some replied that they were out of business, some that they were not in the microalgae industry (any more), some that they were not interested in participating in surveys, and a few never replied. This left a list of 85 potential respondents out of which 37 submitted a completed survey: a response rate of 43,5%

4.5.1 Non-response bias

Since the whole population was initially contacted this is not a random sample. The subset that responded can be suspected not to be representative of the whole population as out of all of them the sample of respondents were the 39.8% out of the entire population of 93 firms (43,5% were the 37 out of 85 that the survey was sent to) that agreed to share possibly sensitive information with an unknown student. To test for potential biases in this sample a construct for comparison was designed, based on the information that was available for all the firms: their web pages. The information that is available from most firm web pages in this industry are firm age, the number of strategic alliances, what type of microalgae activity/ies they perform, whether they generate income from any other activities than microalgae and the quality of the webpage itself. The latter was based on a selective, simplified version of a construct made by (Chiou et al., 2010). The measured criteria were: ease of use, responsiveness, visual appearance, information quality, and trust. Each of these five criteria was rated 0 for below average, 1 for average and 2 for above average giving a possible total score-range from 0 to 10.

An independent t-test was performed in SPSS comparing the means and variances between the subsets of those that responded and the rest of the population. An independent t-test measures the variety and equality of means between two groups (Field, 2009:326,334-35). When Levene's test for equality of variances (see table 4.4) is insignificant ($p>.05$), equality of variances is assumed, and one reads from the according row in the table. If the significance level for the appropriate row is insignificant ($p>.05$), it means that there is not a "significant difference between the means of the two samples." (Field, 2009:340). Looking at Table 5, we see that for the measures extracted from the firm web pages, two of the microalgal activities (act1 and act4) cannot be assumed to have equality of variances, and one of the means (for microalgae activity 2) is significantly different between the two means. However for the majority of the measures, there is not a significant difference between the equality of variances and means. Particularly when accounting for the relatively small sample sizes, there is not a remarkable difference between the responding and non-responding subsets. Hence the respondent sub-set can for all practical purposes be assumed to represent the whole sample.

Table 5 Independent samples t-test for equality of variances and means between the subsets of firms that did and did not respond. Information gathered from firm web pages for all cases. The 'microalgae activities' refer to 1) production of microalgae biomass, 2) production of end products that contain microalgae, 3) production of enabling equipment for microalgae cultivation, harvest, or other parts of the production process, 4) capture carbon and/or decontaminate wastewater with microalgae, 5) other microalgae activities than these four. All the different types of information were not available from every web page, hence a variance of N. Total N is 93.

Variable	N	F	Sig [a]	Mean difference
Firm age	70	1,915	0,171	-1,768
Number of SA	51	1,992	0,164	0,371
Other sources of revenues than microalgae	93	0,593	0,443	-0,039
Web page rating	93	1,832	0,179	-0,731
Microalgae activity 1	93	5,461	0,022	0,080
Microalgae activity 2	93	0,398	0,530	0,211**
Microalgae activity 3	93	0,124	0,725	0,049
Microalgae activity 4	93	10,045	0,002	-0,173*
Microalgae activity 5	93	0,442	0,508	0,017

[a] Significance of Levene's test for equality of variances
** Significant at the 0,05 level
* Significant at the 0,1 level

4.5.2 Item non-response

As can be seen from table 4.5, not all respondents answered every single question. Only 32 respondents fully answered all three of the dependent variable questions (indicated by the variable "Sum of dependent variables"), leaving a smaller sample for analysis than expected from the total response rate. To remedy this, a new dependent variable was defined in SPSS which inserted the average of the present dependent variable(s) if there was at least one in the new joint dependent variable (indicated by "Corrected dependent variable". This function thus also makes the average of all of the dependent variable inputs where they are all present, ultimately changing the values on all of the inputs.

Table 6 Descriptive statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Corrected dependent variable	37	-3,33	6,00	69,67	1,8829	1,96531
Sum of dependent variables	32	-10	18	179	5,59	5,902
DC	37	4	34	666	18,00	7,688
SA	37	4	16	368	9,95	4,000
BB	37	-6	16	225	6,08	6,039
Firm size	37	1	4	67	1,81	,811
Firm age	37	1	16	277	7,49	4,544
Geographic levels of operation	37	1	4	61	1,65	1,160
Microalgae activities performed by firm	37	1	5	84	2,27	1,122
Net profits for 2013	36	-1	4	11	,31	1,618
Increase in net profits from 2012 to 2013	34	-1	4	47	1,38	1,923
Comparison to closest competitor	36	-8	10	141	3,92	3,620
Industry turbulence perceived by firm	37	-2	8	74	2,00	2,261
Valid N (listwise)	32					

4.5.3 Systematic literature search

The electronic databases Web of Science, Biosis and Scopus have been searched on the 3rd of May 2014 in cooperation with a research librarian. Table 7 shows the search strategy for Web of Science. The search strategy was adapted for the other databases. In addition Google Scholar was searched, and reference lists in relevant articles were scanned manually.

Table 7 Search strategy for Web of Science

#8	#6 AND #1 Refined by: LANGUAGES: (ENGLISH)	149
#7	#6 AND #1	152
#6	#5 OR #4 OR #3 OR #2	77188
#5	TS=((business or firm) NEAR/3 specific NEAR/3 strateg*)	103
#4	TS=(brand* OR "business model*" OR "competitive advantag*" OR "dynamic capabilit*" OR "knowledge-creating compan*" OR "resource based")	66987
#3	TS=(strategic NEAR/3 (alliance* OR business* OR relationship* OR network*))	7437
#2	TS=((business* OR commercial* OR manufactur* OR strategic*) NEAR/3 (agreement* OR partner*))	5074
#1	TS=(microalgae* OR algae*)	60356

4.5.4 Ethics of the study

I could not promise the survey participants absolute anonymity for practical reasons. In a completely anonymous survey it is not registered anywhere in any form whom has replied. As mentioned the questionnaire was created and distributed through QuestBack, an internationally renowned and trusted Norwegian survey tool where the participants are

contacted via their email addresses. QuestBack logs which email addresses have completed the survey, in order to not keep sending them reminders. This process is necessary to be able to send out reminders, and it is almost always necessary to send out reminders to receive a high enough response rate. However, this information was only available in my QuestBack account for the duration of the study. No data was exported in a form that could reveal which firms had participated and what they replied.

Another ethical issue was the sizes of the geographical subsets. Some countries, such as the USA, France, and Spain, has a lot of microalgae firms, but some smaller countries with a less developed microalgae industry may only have a couple of firms. Thus although the specific name of the one or two firms that replied from that country would not be published, it may still be easy to deduct for a competitor. Therefore I will not reveal any country-specific information, but instead mention North America vs. Europe when I make geographical comparisons.

5 Results and Analysis

This chapter will present the results from the statistical analyses and analyze the findings in brief. First the correlation between the variables that will be used in the regression analyses will be presented in Table 8, followed by bivariate and multivariate regression analyses presented in tables 5.2, 5.3, and 5.4. In this study OLS regression analyses will be used for testing the hypotheses. A discussion of the implications of the results will be conducted in the next chapter.

5.1 Correlation between the variables

A correlation analysis measures the statistical connection between two variables. This type of analysis does, however, not account for the type of variable (dependent/independent) and does not explain causation (Ringdal, 2007:299). Though it is still useful for observing which variables that coincide the strongest.

Table 8 Pearson correlation of the dependent variable (Performance), the independent variables (DC, SA, BB), and two control variables (firm Size (employees), and Age). N=37 for all variables.

	Perform.	**DC**	**SA**	**BB**	**Size**
Perform.	1				
DC	0,603***	1			
SA	0,439***	0,388**	1		
BB	0,562***	0,498***	0,390**	1	
Size	0,419***	0,258	0,454***	0,275*	1
Age	0,222	0,083	0,425***	0,009	0,486***

*** Correlation is significant at the 0.01 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).

As can be seen from Table 8 the independent variables are moderately correlated with each other, in particular DC and BB at 0,498. The strongest correlations between any of the variables in Table 8 are DC and Performance at 0,603 and BB and Performance at 0,562. Other relatively strong correlations in this plot are SA and Size at 0,454 and Age and Size at

0,486. The Performance variable is correlated with all the other variables except Age, which is only significantly correlated with SA and Size.

5.2 Regression analysis

Among statistical analysis methods, ordinary least squares (OLS) regression analysis is one that is often used to explore the connection between two or more variables (Wilson, 2010:248). Though the different types of regression analyses can be conducted manually, this is very time consuming they are now chiefly calculated by statistical software packages. SPSS was used for all the analyses in this study. An OLS regression analysis will find out if there is a relationship between variables, how strong this relationship is, and its direction. A bivariate regression analysis will look at the effect of one independent variable on a dependent, and a multiple regression analysis measures the effect of multiple independent variables on the dependent. Purposes of multiple regression analysis are to control for additional variables and thus make the model more realistic (Ringdal, 2007:373). The main reasons for doing OLS regression analyses are to make predictions for future outcomes or what are better actions based on gathered data (Field, 2009:198). In the next paragraph I will explain the statistical terms that will be used in the regression analyses.

"The multiple regression correlation coefficient (R^2) is a measure of the proportion of variability explained by, or due to, the linear relationship in a sample of paired data. It is represented by a number between 0 and 1." (Wilson, 2010:248). Beta, or more correctly the standardized beta value, indicates how many 'standard deviations' the dependent variable will change if the independent variable is changed by one 'standard deviation.' "The standardized beta values are all measured in standard deviation units and so are directly comparable: therefore, they provide a better insight into the 'importance' of a predictor in the model." (Field, 2009:239). Higher Beta values mean that the variables are connected to a higher degree. It is not uncommon to view Beta values of >0,5 as strong, 0,3<0,5 as moderate, and <0,3 as weak (Field, 2009:247-261). The confidence interval indicates whether what is claimed by the Beta value is true for 90% (*), 95% (**), or 99% (***) of the cases in the sample being analysed (Field, 2009:240).

37 respondents is not a high number for quantitative studies, and this will affect the statistical analyses. Due to this I will not be able to do multivariate regression models with all the control variables that I gathered through the survey and the traditional firm control variables

Size and Age (Brush and Chaganti, 1999) will have to suffice. Also in smaller samples, a pattern or connection between two variables has to be very strong in order to be significant. Therefore I will use 90% confidence level for rejecting the hypotheses.

Table 9 Bivariate regression analyses of the connections between DC, SA, and BB on the dependent variable. Standardized Beta values and adjusted R^2 values are shown

Variables	Performance	Performance	Performance
DC	0,574***		
SA		0,410**	
BB			0,590***
R^2 (adj)	0,311	0,144	0,329
N	37	37	37

*** Significant at the 0.01 level (2-tailed).
** Significant at the 0.05 level (2-tailed).
* Significant at the 0.1 level (2-tailed).

Table 9 shows the results from the bivariate regression analysis of the influence of each of the independent variables separately on the dependent variable. The Beta values for DC and BB are significant at the 0,01-level and strong. The Beta value for SA is significant at the 0,05-level and of a more moderate strength. The adjusted R^2 values (range from 0-1) are not very high for either of the cases. But what constitutes a good R^2 value depends on what is being measured and how. Some variables can be measured more exactly than others (Ringdal, 2007) (p.371) When measuring firm strategies by a construct in a small sample, it is considered a good model if it explains more than 30% of the variance in performance (Evangelista and Vezzani, 2010).

Thus from the bivariate analyses, it can seem like all three hypotheses are supported, though SA explains less of the variance in firm performance than DC and BB. Bivariate analysis is, however, not enough to test hypotheses. In the following tables and paragraphs the independent variables will be tested with multivariate analysis to control for Size, Age, and each other.

Table 10 Multivariate regression analyses of the effects of DC, SA, BB separately with the control variables firm size and age on the dependent variable. Standardized Beta values and adjusted R^2 values are shown

Variables	Performance	Performance	Performance
DC	0,509***		
SA		0,295	
BB			0,534***
Size	0,245	0,259	0,201
Age	0,027	-0,063	0,086
R^2 (adj)	0,338	0,138	0,356
N	37	37	37

*** Significant at the 0.01 level (2-tailed).
** Significant at the 0.05 level (2-tailed).
* Significant at the 0.1 level (2-tailed).

Table 10 shows the result of a multivariate regression analysis that controls for firm size and age. As mentioned in the method section, size and age are good variables to control for when studying firms (Brush and Chaganti, 1999). The Size variable produces moderately strong Beta values, but is not significant for either of the models. Firm age does not seem to have any effect on performance in either of the models. Only DC and BB shows strong and significant Beta values and their respective models also explain considerably more of the variance in the dependent variable than the SA model. This indicates more support for H1 and H3 than for H2.

Since the independent variables are correlated with each other (see Table 8) a linear regression analysis model with all three independent variables were performed to examine the relative influence of each of them controlled for the others. As can be seen from Table 11, DC and BB again exercise the strongest effect on the dependent variable in the model and are significant at the 0,5-level. This model has a stronger R^2 than the previous models because all three independent variables are highly correlated with the dependent variable (see Table 8).

Table 11 Multivariate regression analysis with the effect of all three dependent variables together on the dependent variable

Variables	Performance
DC	0,339**
SA	0,171
BB	0,369**
R^2 (adj)	0,419
N	37

***Significant at the 0.01 level (2-tailed).
** Significant at the 0.05 level (2-tailed).
* Significant at the 0.1 level (2-tailed).

The findings from the multivariate regression analyses, displayed in Table 10 and Table 11, indicate a stronger support for DC and BB than for SA.

In the next chapter the implications of these findings will be discussed and related to previous research on the topic.

6 Discussion and conclusions

Table 12 Support status for the hypotheses

Hypothesis	Support?
H1: There is a positive relationship between dynamic capabilities and performance in the microalgae industry.	Supported
H2: There is a positive relationship between building strategic alliances as a resource and firm performance for firms in the microalgae industry	Partial support
H3: There is a positive relationship between building brand as a resource and firm performance for firms in the microalgae industry	Supported

As can be seen in Table 12 H1 and H3 are supported, though only partial support was found for H2. These verdicts are based on the regression analyses presented in Table 9, Table 10, and Table 11 in chapter 5. For the bivariate and the multivariate (controlling for Size and Age) regression analyses, DC and BB have significant (99%) Beta values above 0,5, and for the multivariate regression analyses controlling for the independent variables they have significant (95%) Beta values above 0,3. Because the Beta values of DC and BB were all significant at at least the 0,05 level, and relatively strong for measuring these types of variables for such a small sample, H1 and H3 are deemed supported. SA has a significant (95%) Beta value at 0,410 for the bivariate regression analysis. This is the only statistically significant and relatively strong Beta value for SA, and H2 is therefore deemed only partially supported.

6.1 Support for H1 (DC)

To find that DC enhances firm performance in a turbulent, emerging industry was in line with the theoretical predictions, which I tested quantitatively for the microalgae industry. Literature concerning both the microalgae industry specifically, and more generally emerging clean-tech industries such as the bioeconomy, stress that flexibility, adaptability, and dynamicity are key to survival in these fields (Kuehnle and Ritchie, 2013) (Nair and Paulose, 2014) (Golembiewski et al., 2013). This is due to the nature of the emerging clean-tech industries, such as the microalgae industry, and the markets that they serve. The microalgae industry experiences the turbulent conditions termed ‘high velocity’ by Eisenhardt and Martin (2000)

and described as environments “in which market boundaries are blurred, successful business models are unclear, and market players (i.e., buyers, suppliers, competitors, complementers) are ambiguous and shifting. The overall industry structure is unclear.” (Eisenhardt and Martin, 2000). This description concurs with Nair and Paulose’s (2014) description of the microalgae industry. Novel business models are often needed in order to exploit new technology and opportunities (Nair and Paulose, 2014), and DC is an instrument that can aid firms in finding the most suitable business model for their technology and available market opportunities.

Some of the new clean-tech industries are based on the merging of two or more industries. This is for example the case for the bioenergy industry, studied by Golembiewski et al. (2013), which was assumed to be formed by the convergence of the energy and the agricultural industries, but their findings showed that bioenergy endeavours were mainly based on cooperation between energy and biotech firms, including firms from the microalgae industry. (Golembiewski et al., 2013) This occurred because adaptive microalgae firms detected the market opportunity and made the necessary changes to their organization to seize these opportunities (Nair and Paulose, 2014).

Though the presence of DC in a firm was difficult to measure quantitatively, an effort was made to extract mentioned DC tactics from articles describing this strategic, intangible resource.

6.2 Support for H3 (BB)

To find support for brand as a performance-enhancing strategy in the microalgae industry was not as expected as for DC, because of less focus on brand in the literature on this and other emerging industries. BB was only mentioned as a minor point in the microalgae firm strategy literature, and has not been a main concern in literature on other clean-tech industries. Though from observing the web pages of successful microalgae firms, it appears that many of them are in fact conscious of this concept as a strategic resource. Sarkar (2012) focuses on the increasing impact green branding has on consumers, something that firms in the microalgae industry should use to their advantage. Nair and Paulose (2014) mention that the desire for building greener brands in other industries, such as the aviation industry, also can be an opportunity for microalgae firms. This can potentially open up for new opportunities for microalgae firms in all markets served by industries that could benefit from appearing more environmentally friendly.

Branding is increasingly emphasized as a performance enhancing factor for all types of firms and organizations (Kalafatis et al., 2012). Though the focus on brand as a resource is no longer limited to consumer products, many firms catering to B2B markets, as is common in the microalgae industry, lags behind in realizing the value of this intangible resource for their firm, products, and services (Kapferer, 2012:116-117). Most of the time people are not aware that they experience brands, which is what makes them powerful (Baumgarth and Schmidt, 2010). This makes brand not just a valuable intangible resource, but also rare and inimitable (Kozlenkova et al., 2013). Even within organizational buying (B2B-markets), the people in charge of purchases know what they know about the products they purchase, but not necessarily how they feel about them (Kalafatis et al., 2012). The literature suggests that people are much more likely to trust a well-administered brand (Kapferer, 2012:113-114). This also connects BB to SA: a well-managed brand will enhance a firm's perceived desirability for alliance-forming.

Brand is part of a firm's market orientation, and firms with a higher degree of market orientation ultimately perform better than firms who does not have a well-developed market orientation (Hooley et al., 2005). One can imagine this to especially be the case in an emerging industry which offers products or services that the potential customer may not be familiar with. Commonly, new technology ventures led by scientists will not heed the importance business elements such as marketing (Allen, 2010:52-54). Nair and Paulose (2014) state that "an important factor that determines the position of a firm in the industry is its brand management capabilities. [...] Efficient brand management is a prerequisite for developing supply chain networks and forming partnerships".

6.3 Partial support for H2 (SA)

The lesser support for SA as enhancing for firm performance is the most surprising finding from this study, relative to extant literature. Both articles I found on firm specific strategies in the microalgae industry underlined forming alliances as one of the most important strategies for firms in this industry (Nair and Paulose, 2014) (Kuehnle and Ritchie, 2013). Since this hypothesis was only partially supported it may reflect more on the way that SA as a strategy was measured, rather than whether this is a good strategy for this industry or not. The SA-variable was measured solely by adding up strategic alliances that the firm had been involved in over the past three years, because I tried to keep the survey short and the questions

somewhat straightforward and easy. Some more in-depth questions about e.g. the firms' attitudes towards SA or whether they organized the firms to accommodate alliance-based strategies could have been added to improve the construct.

SAs are also a way for smaller, younger firms in turbulent environments to find a stronger foothold in markets through co-branding efforts and the support from stronger value chain connections (Nair and Paulose, 2014). Being associated with another organization can be a way to gain attention and recognition. The one firm's reputation and brand will become a resource for building the other firm's brand (Eisenhardt and Schoonhoven, 1996). Strategic relationships with other firms will also increase the firms exit options (Kuehnle and Ritchie, 2013). However, as the survey only investigated SAs over the past three years, and performance over the past two, the benefit of SA as an exit strategy would not have been captured by this study. These types of benefits align with the RBV literature on viewing SAs as resources in themselves (Eisenhardt and Schoonhoven, 1996) (Das and Teng, 2000).

Firms operating in evolving, unpredictable environments such as the microalgae industry, may experience resource gaps due to changes that must be made to capture opportunities or evade threats. The other main view of SA within the RBV framework is as a way to swiftly gain resources and capabilities (Teng, 2007). These benefits of forming SAs will yield faster results on the performance, and should have been detected by the survey.

The future of the microalgae industry seems intertwined with industrial ecology as production of microalgae can purify different forms for unwanted by-products from other production processes (Nair and Paulose, 2014) (Kuehnle and Ritchie, 2013) (Pauli, 1997). In these settings the co-operation between firms or organizations goes beyond what is usually understood by strategic alliances and becomes embedded in the business model. The literature therefore predicts that alliances and other forms of inter-organizational co-operation is, and perhaps even increasingly will be, important for the microalgae industry, despite the lower support for H2.

6.4 Other findings

6.4.1 The control variables

Neither firm size nor age has significant Beta values in the multivariate regression analyses that included control variables. Size had stronger Beta values than Age, which was close to 0 for all three independent variables, but they were still below 0,3 and thus considered weak. Age was measured from 1 year to >15 years with a mean of 7,49 years, and its Beta values indicate that this variable exercises practically no effect on firm performance. This indicates that long experience is not inevitably valuable to a firm in the microalgae industry, and indirectly this concurs with the support for DC as a positive influence firm performance. DC is not necessarily a product of long experience, quite the contrary 'firm traditions' and set ways of doing things are discordant with DC (Newbert, 2005). Firm size influences performance more, though not significantly in the multivariate regression models. If considering that the lowest answer alternative for the firm size (by number of employees) question is 'less than 5' full time employees, and how many employees (both scientific and administrative) realistically would be needed to run a firm that e.g. produces and sells commercial quanta microalgal ingredients extracted from biomass which has been cultivated in ponds or PBRs, it makes sense that a smaller firm size is not correlated with higher performance in this industry.

In the correlation table (Table 8) there is 'grouping' between the three variables SA, Size, and Age, where they are all significantly correlated with each other above 0,4. This is relatively high for these three variables, and out of them only SA and Size is correlated with Performance at this significance level, and above 0,4. SA also correlates higher with Size and Age than with DC and BB. It may be an indication that older and larger firms have a higher occurrence of SAs, as the literature suggests, because they have more employees to make connections, and longer experience to build a network (Eisenhardt and Schoonhoven, 1996).

6.4.2 Correlation between the strategies

The independent variables that are the basis for measuring the hypotheses are fairly correlated with each other (see Table 8). It may seem like the three strategies that form the basis for the independent variables are not highly connected, but this depends on how they are approached.

If the firm is imagined as a separate entity from its environment, all three strategies describe how the firm relates to its environment. DC to what degree the firm adapts organizationally to changes in the environment, SA to what degree the firm connects with other entities in the environment, and BB to what degree the firm controls how it, and its products or services, are perceived by the environment. Thus firms which do not isolate themselves, but are conscious of their place in the environment, and how their interaction with it will affect their performance in the long run, may have obtained this consciousness for more than one area of interaction with the environment. In the conditions that are typical for the microalgae industry, strategies are likely to take the form of pattern strategies, rather than plan strategies, the difference being in the emphasis on meticulous analysis and pre-planning, and the linearity and predictability of the changes (Mintzberg, 2003:315-332).

The literature also mention connections between the three strategies: DC can create resource gaps, which strategic alliances may help fill (Teng, 2007), and BB will make firms more eligible for SAs (Nair and Paulose, 2014)

6.4.3 Limitations of this study

This study has limitations in regards to drawing conclusions about performance-enhancing firm strategies in the microalgae industry. It is a cross sectional study with the primary data gathered from a survey, and though the questions measuring the independent variables were asked in regards to activities performed over the last three years, and two out of three performance measures were asked regarding performance in 2013, it would be incorrect to claim with certainty that the independent variables caused effects on the dependent variables.

Other limitations are the absolute value of respondents, which is not high above the limit for what is acceptable to use for quantitative analyses, and that the questions of the survey could have been constructed better, particularly the question measuring SA.

The causality limitation could have been ameliorated by performing a longitudinal study, or by using a mixed methods research design to gather both qualitative and quantitative data. The total number of respondents may have been increased by calling each firm to establish more trust. If the thesis had been written over a longer time period, a pilot test of the survey could have been performed, and employees in microalgae firms could have been consulted in regards to improving the survey questions and thus the construct.

6.5 Conclusions

Although this is a quantitative study, it is not the type of study that can ultimately prove or disprove a theory, but rather find indications of what are favourable actions or behavior patterns.

Applying tactics described by the DC framework is found to correlate with higher performance among firms in the microalgae industry. This was expected and can be explained by the nature of the industry, being emerging, high-tech, and turbulent. These are the types of conditions that the DC literature describes as the origin of DC (Eisenhardt and Martin, 2000) (Ambrosini and Bowman, 2009) (Day, 2013) (Newbert, 2005). This finding also concurs with the literature on firm strategy in the microalgae industry: “to be competitive in these dynamic environments, they must be flexible enough to respond effectively to changes. Flexibility is thus a dynamic capability of the business model”, “the new market mechanism is a dynamic, evolving opportunity, and adapting to it requires firms to have dynamic, flexible business models that enable them to exploit opportunities” (Nair and Paulose, 2014). “Key to our success in developing KAS’s initial commercial relationships have been two main factors: establishing an innovation track record; and demonstrating flexibility and responsiveness in meeting customer needs” (Kuehnle and Ritchie, 2013). Ergo this study confirmed this extant theory on firm strategy in the microalgae industry.

The findings from this study only partially supports SA as a performance enhancing activity for firms in the microalgae industry. This does not concur with the extant literature on this topic, and it can be assumed that the fault lies with the construct measuring this strategy rather than with the theory.

BB correlates with higher performance for firms in the microalgae industry. Brand has only been mentioned in passing in the extant literature on the microalgae industry, though the body of literature on the topic of firm-specific strategies in this industry is insofar small. Though the number publications on brand and marketing as resources grows rapidly (Kozlenkova et al., 2013) and it may yet become an important topic in the literature on this industry. The findings from this study certainly points in that direction.

My contribution to literature on firm specific strategies in the microalgae industry will (to the best of my knowledge) constitute ⅓ of all published documents in this genre. How important this study will be is another question, as it may be argued that 37 respondents for a

quantitative study is too low to give it much weight. Yet, since so little is written on this topic it may suffice for people who are interested in learning more about performance enhancing strategies in this industry. Neither Nair and Paulose (2014) nor Kuehnle and Ritchie (2013) performed a quantitative study, as their research was based on case studies and experience. What quantitative studies lack in depth, they make up for in width and representativeness (Wilson, 2010:13-15), so my approach will complement the previous studies.

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